MONITORING PLAN
PROJECT NO. C/S-23
REPLACE HOG ISLAND GULLY, WEST COVE, AND HEADQUARTERS CANAL STRUCTURES

DATE: June 16, 1999

Project Description

The Replace Hog Island Gully, West Cove and Headquarters Canal Structures (C/S-23) project area is located within the Sabine National Wildlife Refuge, approximately 9 mi (14.5 km) south of the town of Hackberry in Cameron Parish, Louisiana (figure 1). Established on December 6, 1937, the Sabine Refuge is bound on the east by Calcasieu Lake, on the west by Sabine Lake, on the north by broken marsh, and on the south by pasture land and coastal ridges. The refuge encompasses approximately 124,511 acres (50,402 ha) of interspersed fresh, intermediate, brackish, and saline marshes. The project area comprises 42,247 acres (17,102 ha) and supports diverse vegetative and wildlife communities (United States Fish and Wildlife Service [USFWS], 1999).

O'Neil (1949) characterized the project area wetlands as fresh to intermediate marshes dominated by Jamaica sawgrass (*Cladium jamaicense*). The Black Lake area, located north of the project, experienced an 81% reduction in the acreage of emergent wetlands between 1952 and 1974 (Adams et al. 1978). By 1972, the Black Lake area was characterized as brackish marsh (Chabreck and Linscombe 1978). A number of factors such as salinity stress, erosion, subsidence, burning and hydrologic modification influenced this habitat change. For example, in 1957, Hurricane Audrey inundated the area with saltwater, impacting freshwater emergent vegetation which disappeared in the late 1950's and early 1960's (Valentine 1979). This left large expanses of open water in the refuge. Rogers and Herke (1985) indicated that the soil is highly organic and subject to erosion when unvegetated. In addition, the extraction of oil and gas in the area may have induced subsidence, as documented in east Texas (Weaver and Sheets 1962). Prescribed burning has also influenced habitat change. It is a management practice conducted every three to four years to control the growth of undesirable plant species. The largest influence has probably been manmade changes to the hydrology of the area. The Calcasieu Ship Channel was dredged to its current depth of 40 ft (12.2 m) in 1968 (Good et al. 1995), and construction of Highway 27 has increased water and soil salinities, changed the distribution and circulation of saltwater, and disrupted the natural hydrology and ecology of a large portion of the refuge marshes (Valentine 1979).

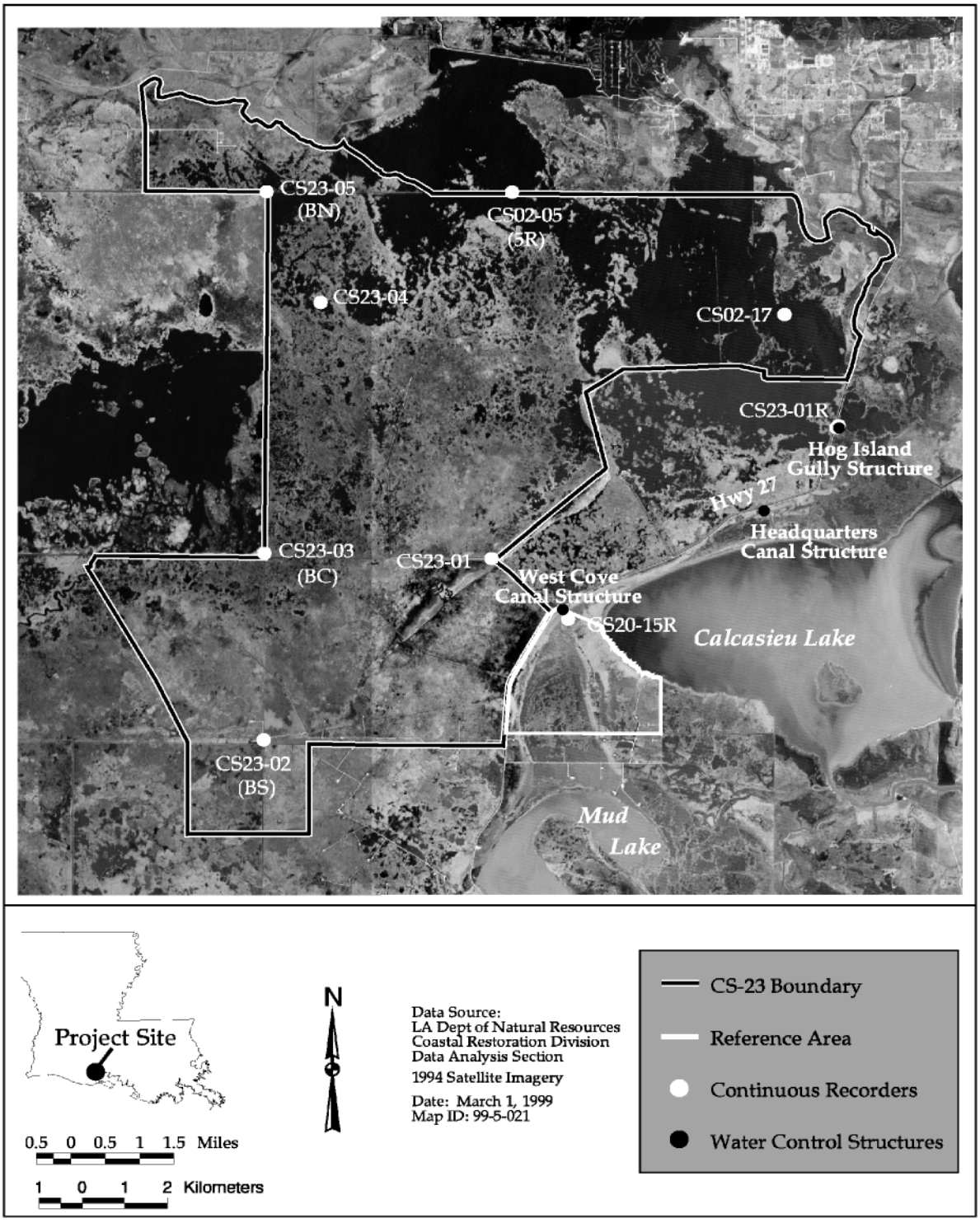

Figure 1. Replace Hog Island Gully, West Cove Canal, and Headquarters Canal Structures (CS-23) project features, project area boundaries, and reference area boundaries.

Since there are primarily three avenues for water passage (Hog Island Gully, West Cove Canal, and Headquarters Canal) in the area, the feasibility of water management by weirs was investigated in the 1970's. Although some opposition was encountered from concerned commercial fishermen, the first structures were completed in 1981. These structures have corroded with the continuous exposure to saline water to the extent that they are inoperable or almost inoperable.

Due to the detrimental impacts of excessive salinity on brackish and intermediate marshes, the ability to occasionally reduce or halt the inflow of saline water is critical. This level of control is not available with the present structures because, for example, during periods of high tide, large volumes of high salinity water (> 20 ppt) flow over the weir crests which are set at +1.5 ft MSL. The inability to manipulate gate structures has jeopardized the integrity of thousands of acres of interior brackish and intermediate marshes which are lower in elevation and often occur in highly organic semifloating soils. The estimated subsidence rate in the project marshes ranges between 0.12 in/yr and 0.16 in/yr (0.32 and 0.42 cm/yr) (Penland et al. 1989). Because of the restricted cross-sectional area of the existing structures and culverts, the lower elevation interior marshes experience longer periods of vegetative water logging stress than the marshes located east of Highway 27. The existing structures afford the primary avenues for drainage and are inadequate to provide sufficient discharge to evacuate excess water. Due to the project area not being fully enclosed, secondary drainage for the area can occur to the west through Sabine Lake via North, Central and South line canals.

In September 1996, the USFWS began development of the draft environmental assessment (EA) plan addressing the Replacement of Water Control Structures at Hog Island Gully, West Cove Canal, and Headquarters Canal (C/S-23). The plan calls for the complete removal of the Hog Island Gully Structure, West Cove Canal Structure, and Headquarters Canal Structure and replacement with additional structures and culverts to provide larger cross sections for water removal and to minimize saltwater intrusion.

The proposed Hog Island Gully structure will be located approximately 200 ft (61 m) east of the existing structure and will increase the cross sectional area by 212.5 ft^2 (19.1 m^2) (table 1). The proposed structure will contain four 7.5 ft (2.3 m) wide gates and two 3.0 ft (0.9 m) wide gates. Each bay will be 8 ft (2.4 m) deep and equipped with stop logs to preclude all water flow. Of the four 7.5 ft (2.3 m) gates, three will have exterior flapgates so that water flows can be precisely regulated at critical periods throughout the year.

The proposed West Cove Canal structure will be located approximately 200 feet (61 m) east of the existing structure and will increase the cross sectional area by 182.5 ft^2 (16.4 m^2) (table 1). The proposed structure will contain three 7.5 ft (2.3 m)wide gates and two 3.0 foot (0.9 m) wide gates. Each bay will be 8 ft (2.4 m) deep and equipped with stop logs to preclude all water flow. Of the three 7.5 ft (2.3 m) gates, two will have exterior flapgates so that water flows can be precisely regulated at critical periods throughout the year.

The Headquarters Canal Structure will be refurbished in its present location and will increase the cross sectional area by 46.4 ft^2 (4.2 m^2) (table 1). The new structure will consist of three 5.0 ft (1.5

m) diameter culverts. The top of each culvert will be set at approximate marsh level. Each culvert will be equipped with an interior sluice gate and exterior flap gate.

The replacement structures will be operated to more effectively discharge excess water, increase cross sectional area for ingress/egress of estuarine dependent species and more effectively curtail saltwater intrusion into the interior marshes. Upon completion of the new structures, high saline waters can be precisely controlled, water discharge capacities will be increased, and vegetative stress through water logging will be minimized, thus enhancing emergent and submergent vegetative growth. The proposed action is estimated to restore 367 acres (149 ha), protect 586 acres (237 ha), and enhance 42,247 acres (17,102 ha) of intermediate and brackish marshes over the 20-yr life of the project (LDNR 1983).

Table 1. Cross sectional area of existing and proposed water control structures affecting the (C/S-23) project area (United States Fish and Wildlife Service, 1999).

Structure	**Existing**		**Proposed**		**Increase in Area**	
	(f^2)	**(m^2)**	**(f^2)**	**(m^2)**	**(f^2)**	**(m^2)**
Hog Island Gully	93.5	(8.4)	306.0	(27.5)	212.5	(19.1)
West Cove Canal	59.5	(5.3)	242.0	(21.7)	182.5	(16.4)
Headquarters Canal	12.6	(1.1)	59.0	(5.3)	46.4	(4.2)
Total	**165.6**	**(16.8)**	**607.0**	**(54.5)**	**441.4**	**(39.7)**

Project Objective

1. Increase the cross-sectional area of the project features to improve hydrologic conditions that control high saline waters, increase water discharge capacities, and maintain emergent vegetation.

Specific Goals

1. Reduce the occurrence of salinities that exceed target levels at stations CS23-02 (BS), CS23-03 (BC), CS23-05 (BN) and CS02-05 (5R).

2. Minimize frequency and duration of marsh flooding events.

3. Maintain existing intermediate and brackish vegetation communities.

4. Increase occurrence of submerged aquatic vegetation (SAV).

Reference Area

The importance of using appropriate reference areas cannot be overemphasized. Monitoring on both project and reference areas provides a means to achieve statistically valid comparisons, and is therefore the most effective means of evaluating project success. The evaluation of sites was based on the criteria that both project and reference areas have a similar vegetative community, soil type, and hydrology. The project area, classified as a brackish/intermediate marsh and the reference area, classified as a brackish marsh (Chabreck and Linscombe 1978), contain mainly the organic Creole and Bancker soils (United States Department of Agriculture [SCS] 1995).

The area north of Magnolia Road and east of Hwy 27 has been chosen as a suitable reference area for the monitoring of emergent and submerged aquatic vegetation, water levels, and salinities (figure 1). Both areas are influenced hydrologically by the Calcasieu Ship Channel and Calcasieu Lake through West Cove Canal and are dominated by *Spartina patens* (marshhay cordgrass). The reference area is presently being used as the reference for the East Mud Lake (C/S-20) project. Pre-construction data for vegetation, water level and salinity data within the reference area is available from 1995 and 1997. The (C/S-23) data collection procedures and dates will coincide with (C/S-20) data collection procedures and dates to comply with budgetary constraints.

Monitoring Elements

The following monitoring elements will provide the information necessary to evaluate the specific goals listed above:

1. Aerial Photography- To document land and water acreage and land loss rates in the hydrologic unit, reference area, and whole project area, color infrared aerial photography (1:12,000 scale with ground controls) of the project and reference areas will be obtained. The photography will be georectified by National Wetlands Research Center (NWRC) personnel following procedures described in Steyer et al. (1995), but detailed photo interpretation, mapping, and GIS is not planned. The photography will be obtained prior to construction in 1999 and after construction in years 2004, 2009, and 2018.

2. Salinity- Salinities will be monitored hourly utilizing nine continuous recorders. Six will be located in the project area, two in the reference area and one outside of the project area within Hog Island Gully Canal. Six recorders are associated with this project, two associated with Rycade Canal (CS02-05, CS02-17) and one from East Mud Lake (CS20-15R) (figure 1). Discrete salinities are being collected bi-weekly at 15 stations in the project and reference areas by USFWS and will be provided to DNR each month. Both discrete and continuous data will be used to characterize frequency and duration

of average annual salinities throughout the project and reference area. Salinity data will also be used to identify occurrences of salinities that exceed target levels at stations CS23-02 (BS), CS23-03 (BC), CS23-05 (BN) and CS02-05 (5R). Salinity will be monitored in 1998-1999 (preconstruction) and in 2000-2018 (postconstruction).

3. Water Level- To document annual duration and frequency of flooding, water levels will be monitored hourly at continuous recorder stations located in the project and reference area sites (figure 1). A staff gauge will be surveyed adjacent to the continuous recorders so as to tie recorder water levels to a known datum. Marsh elevations have been established at stations (CS23-02, CS23-03, CS23-05, CS02-05, CS02-17, CS20-15R) and will be used to evaluate 1998-1999 (preconstruction) and 2000-2018 (postconstruction) data sets.

4. Vegetation- Species composition, richness and relative abundance will be evaluated in the project and reference areas using techniques described in Steyer et al (1995). More specifically, the Braun-Blanquet method (Mueller-Dombois and Ellenberg 1974) will be utilized. Fifty $4m^2$ sample areas (replicate 2m x 2m plots) will be used to monitor percent cover, species composition, and height of dominant plants. Forty plots will be located in the project area and ten existing plots will be in the reference area. The plots will be established along a North/South transect line and will be marked by GPS points and PVC poles to allow revisiting over time. Vegetation will be monitored once in 1999 (preconstruction) and then in years 2004, 2009, 2014, and 2018.

5. Submerged Aquatic Vegetation- To determine the occurrence of submersed aquatic vegetation (SAV) within the project and reference area, eight ponds will be randomly sampled for presence or absence of SAV using the modified rake method (Nyman and Chabreck1996). Five ponds will be located in the project area and three in the reference area. Transect lines will be set up within each pond and a minimum of 25 samples will be taken along each transect line, not to exceed 100 samples per line. Depending on pond configuration and wind direction, the number of transect lines within each pond will vary. SAV's will be monitored in 1999 (preconstruction) and then in years 2004, 2009, 2014, and 2018.

Anticipated Statistical Analyses and Hypotheses

The following paragraphs describe statistical tests that will be used to analyze data collected for each monitoring element included in this monitoring plan to evaluate the accomplishment of the project goals. The numbers to the left correspond to the monitoring elements described above. These are followed by statements of the project goals, and the hypotheses that will be used in the evaluation.

1. Aerial Photography: Descriptive and historical data (for 1956, 1978, and 1988) from color-infrared aerial photography collected pre- and postconstruction will be used, along with GIS interpretations of these data sets, to evaluate marsh to open water ratios and changes in the rate of marsh loss/gain in the project area.

   Goal: Reduce existing rate of loss of emergent marsh.

   Hypothesis[1]:

   H_0^1: Marsh loss rate within the project area at time point *i* will not be significantly less than marsh loss rate preconstruction.

   H_a^1: Marsh loss rate within the project area at time point *i* will be significantly less than marsh loss rate preconstruction.

   Hypothesis[2]:

   H_0^2: Marsh loss rate within the project area at time point *i* will not be significantly less than postconstruction marsh loss rate within reference area.

   H_a^2: Marsh loss rate within the project area at time point *i* will be significantly less than postconstruction marsh loss rate within reference area.

2. Salinity: Within a given sampling period, appropriate parametric and/or nonparametric methods will be used to test the following hypotheses.

   Goal: Reduce the occurrence of salinities that exceed target levels at stations CS23-02 (BS), CS23-03 (BC), CS23-05 (BN) and CS02-05 (5R).

   Hypothesis[1]:

   H_0^1: The occurrence of salinities that exceed target levels in the project area postconstruction will not be significantly lower than the occurrence of salinities that exceed target levels in the project area preconstruction.

   H_a^1: The occurrence of salinities that exceed target levels in the project area postconstruction will be significantly lower than the occurrence of salinities that exceed target levels in the project area preconstruction.

Hypothesis[2]:

H_0^2: The occurrence of salinities that exceed target levels in the project area postconstruction will <u>not</u> be significantly lower than the occurrence of salinities that exceed target levels in the reference area postconstruction.

H_a^2: The occurrence of salinities that exceed target levels in the project area postconstruction will be significantly lower than the occurrence of salinities that exceed target levels in the reference area postconstruction.

3. <u>Water Level</u>: Within a given sampling period, appropriate parametric and/or nonparametric methods will be used to test the following hypothesis.

Goal: Decrease duration and frequency of inundation.

Hypothesis[1]:

H_0^1: Duration and frequency of inundation postconstruction in the project area will <u>not</u> be significantly lower than duration of inundation preconstruction in the project area.

H_a^1: Duration and frequency of inundation postconstruction in the project area will be significantly lower than duration of inundation preconstruction in the project area.

Hypothesis[2]:

H_0^2: Duration and frequency of inundation postconstruction in the project area will <u>not</u> be significantly lower than duration of inundation postconstruction in the reference area.

H_a^2: Duration and frequency of inundation postconstruction in the project area will be significantly lower than duration of inundation postconstruction in the reference area.

4. <u>Vegetation</u>: Within a given sampling period, appropriate parametric and/or nonparametric methods will be used to test the following hypothesis.

Goal: Maintain the percent cover, richness and vegetation height within the project area.

Hypothesis[1]:

H_0^1: Percent cover, richness and vegetation height within the project area postconstruction will be less than mean percent cover, richness and vegetation height within the project area preconstruction.

H_a^1: Percent cover, richness and vegetation height within the project area postconstruction will be the same or greater than mean percent cover, richness and vegetation height within the project area preconstruction.

Hypothesis[2]:

H_0^2: Percent cover, richness and vegetation height within the project area postconstruction will be less than mean percent cover, richness and vegetation height within the reference area postconstruction.

H_a^2: Percent cover, richness and vegetation height within the project area postconstruction will be the same or greater than mean percent cover, richness and vegetation height within the reference area postconstruction.

5. Submerged Aquatic Vegetation: Within a given sampling period, appropriate parametric and /or nonparametric methods will be used to test the following hypothesis.

Goal: Increase the frequency of occurrence of SAV's in shallow open water within the project area.

Hypothesis[1]:

H_0^1: Frequency of occurrence of SAV in the project area postconstruction will not be significantly greater than the frequency of occurrence of SAV preconstruction.

H_a^1: Frequency of occurrence of SAV in the project area postconstruction will be significantly greater than the frequency of occurrence of SAV preconstruction.

Hypothesis[2]:

H_0^2: Frequency of occurrence of SAV in the project area postconstruction will not be significantly greater than the frequency of occurrence of SAV postconstruction in the reference area.

H_a^2: Frequency of occurrence of SAV in the project area postconstruction will be significantly greater than the frequency of occurrence of SAV postconstruction in the reference area

Available ecological data, including both descriptive and quantitative data, will be evaluated in concert with the statistical analyses to aid in determination of the overall project success. This includes ancillary data collected in this monitoring project but not used directly in statistical analyses, as well as data available from other sources (USACE, USFWS, DNR, LSU, etc.).

Notes:

1.	Implementation:	Start Construction	10/01/99
		End Construction	08/01/00
2.	USFWS Point of Contact:	Darryl Clark	(318) 291-3111
3.	DNR Project Manager:	Clay Menard	(318) 893-2769
	DNR Monitoring Manager:	Mike Miller	(318) 893-1256
	DNR DAS Assistant:	Mary Horton	(225) 342-4122

4. The twenty year monitoring plan development and implementation budget for this project is $836,094. Progress reports will be available in January 2001, January 2002, January 2004, January 2005, January 2007, January 2008, January 2010, January 2011, January 2013, January 2014, January 2016 and January 2017, and comprehensive reports will be available in January 2003, January 2006, January 2009, January 2012, January 2015 and January 2020. These reports will describe the status and effectiveness of the project.

5. Salinity and water level data within the project and reference area have been collected since March 1998, to obtain preconstruction data.

6. After year 2007, three continuous recorders will be used to collect water quality data within the project area instead of six.

7. Structure operations will be performed by Sabine National Wildlife Refuge personnel.

8. Prescribed burning, to control growth of undesirable plant species is practiced by the USFWS every three to four years within the vegetative sampling area. Vegetative markers used to locate vegetative plots over time will need to be fire retardant.

9. References:

Adams, R. D., P. J. Banas, R. H. Baumann, J. H. Blackmon, and W. G. McIntire 1978. Shoreline erosion in coastal Louisiana: inventory and assessment. Baton Rouge: Louisiana Department of Transportation and Development, Coastal Resources Program. 139 pp.

Chabreck, R. H. and G. Linscombe 1978. Vegetative type map of the Louisiana coastal marshes. New Orleans: Louisiana Department of Wildlife and Fisheries. Scale1:62,500.

Good, B.,J. Buchtel, D. Meffert, J. Radford, K. Rhinehart, and R. Wilson 1995. Louisiana's Major Coastal Navigational Channels. Unpublished report. Baton Rouge: Louisiana Department of Natural Resources, Office of Coastal Management and Restoration. 57 pp.

Louisiana Department of Natural Resources (LDNR) 1983. Wetland Value Assessment Community Model for Replacement of Water control structures at Hog Island Gully, West Cove Canal, and Headquarters Canal (XCS-47/48). pp. 12

Mueller-Dombois, D. and H. Ellenberg1974. Aims and Methods of Vegetation Ecology. New York: John Wiley and Sons. 547pp.

Nyman, J. A., and R. H. Chabreck 1996. Some effects of 30 years of weir management on coastal marsh aquatic vegetation and implications to waterfowl management. Gulf of Mexico Science 14: 16-25.

O'Neil, T. 1949. Map of the southwestern part of Louisiana showing vegetation types of the Louisiana marshes. New Orleans, La. Louisiana Department of Wildlife & Fisheries.

Penland, S., K. E. Ramsey, R. Macbride, T. F. Moslow, and K. Westphal 1989. Relative sea level rise and subsidence in coastal Louisiana and the Gulf of Mexico. Coastal Geology Technical Report No. 3. Baton Rouge: Louisiana Geological Survey.

Rogers, B. D., and W. H. Herke 1985. Estuarine dependent fish and crustacean movements and weir management. Fourth Coastal Marsh and Estuary Management Symposium pp.201 -219

Siegel, and N. J. Castellan 1988. Nonparametric statistics for behavioral sciences. New York: McGraw-Hill, Inc., 2nd edition. 384 pp.

Steele, R. G. D., and J. H. Torrie. 1980. Principles and procedures of statistics: a biometrical approach. New York: McGraw-Hill, Inc. 633 pp.

Steyer, G. D., R. C. Raynie, D. L. Steller, D. Fuller, and E. Swensen 1995. Quality management plan for Coastal Wetlands Planning, Protection, and Restoration Act monitoring program. Open-file series no. 95-01. Baton Rouge: Louisiana Department of Natural Resources, Coastal Restoration Division.

United States Department of Agriculture, Soil Conservation Service 1995. Soil survey of Cameron Parish, Louisiana. Publication No. 1995-386-441/00020. Washington, D.C.: U.S. Government Printing Office. 135 pp, 122 maps. Scale 1:20,000.

United States Fish and Wildlife Service, Sabine National Wildlife Refuge 1999. Draft Environmental Assessment. Replacement of Water control structures at Hog Island Gully, West Cove Canal, and Headquarters Canal. Hackberry, Louisiana: Sabine National Wildlife Refuge.

Valentine, J. M. 1979. An evaluation of the proposed water control structures on water quality, vegetation, estuarine-dependent fisheries, and other wildlife-Appendix L. U.S. Fish and Wildlife Service.

Weaver, P., and M. M. Sheets 1962. Active Faults, subsidence, and foundation problems in the Houston Texas area. In *Geology of the Gulf Coast and Central Texas*. Houston, Tx.: Houston Geological Society. pp. 254-265.

_____ n. d. Salinity and water level data collected at Sabine National Wildlife Refuge. Unpublished report.